

## 21.13 ELECTRODE

ELECTRODE specifies the locations and names of electrodes in a previously defined mesh.

### Syntax

```
ELECTRODE NAME=<en> [NUMBER=<n>] [SUBSTRATE] <pos> <reg>
```

Parameter	Type	Default	Units
A.MAX	Real		degrees
A.MIN	Real		degrees
BOTTOM	Logical	False	
FLOATING	Logical	False	
IX.HIGH	Integer	right side of structure	
IX.LOW	Integer	left side of structure	
IX.MAX	Integer	right side of structure	
IX.MIN	Integer	left side of structure	
IY.MAX	Integer	bottom side of structure	
IY.MIN	Integer	top side of structure	
IY.HIGH	Integer	bottom of structure	
IY.LOW	Integer	top of structure	
IZ.MAX	Integer		
IZ.MIN	Integer		
IZ.HIGH	Integer		
IZ.LOW	Integer		
LEFT	Logical	False	
LENGTH	Real	length of structure	μm
MATERIAL	Character	Contact	
MODIFY	Logical	False	
NAME	Character		
NUMBER	Integer	defined #(electrodes)+ 1	
R.MAX	Real		μm
R.MIN	Real		μm
RIGHT	Logical	False	
SUBSTRATE	Logical	False	

Parameter	Type	Default	Units
THERMAL	Logical	False	
TOP	Logical	False	
X .MAX	Real	right side of structure	μm
X .MIN	Real	left side of structure	μm
Y .MAX	Real	Y .MIN	μm
Y .MIN	Real	top of the structure	μm
Z .MIN	Real		μm
Z .MAX	Real		μm

## Description

<b>FLOATING</b>	Marks an enclosed electrode as a floating semiconductor region. See <a href="#">Section 3.5.10 “Floating Semiconductor Regions”</a> .
<b>MATERIAL</b>	Specifies a material for the electrode (see <a href="#">Table B-1</a> ). This material will be displayed in TONYPLOT. The electrode material can also be used to define the electrode thermal characteristics (thermal conductivity) and optical characteristics (complex index of refraction). Setting the material here does not apply any electrical property such as workfunction to the terminal. All electrical properties of electrodes are set on the CONTACT statement.
<b>MODIFY</b>	To mark an electrode read from a Standard Structure File as a floating semiconductor region specify both MODIFY and FLOATING flags. See <a href="#">Section 3.5.10 “Floating Semiconductor Regions”</a> .
<b>NAME</b>	<p>Specifies an electrode name. The electrode name can be referenced by other ATLAS statements to modify characteristics of the specified electrode. For reference by the CONTACT or THERMALCONTACT statements any valid character string can be used and properly cross-referenced. But when setting voltages, currents and charge from the SOLVE statement certain electrode names are recognized in a simplified syntax. By prepending the electrode name with "V" for voltage, "I" for current and "Q" for charge, you can directly and conveniently set the electrode bias, current or charge respectively. For example:</p> <pre>SOLVE VGATE=1.0</pre> <p>can be used to assign 1 volt bias to the electrode named "GATE". In such a manner, the following list of names can be used to set voltage, current or charge.</p> <ul style="list-style-type: none"> <li>• GATE</li> <li>• FGATE</li> <li>• CGATE</li> <li>• NGATE</li> <li>• PGATE</li> <li>• VGG</li> </ul>

The following list of names can be used to assign only voltage or current.

- DRAIN
- SOURCE
- BULK
- SUBSTRATE
- EMITTER
- COLLECTOR
- BASE
- ANODE
- CATHODE
- WELL

- NWELL
- PWELL
- CHANNEL
- GROUND
- NSOURCE
- PSOURCE
- NDRAIN
- PDRAIN
- VDD
- VSS
- VEE
- VBB
- VCC

<b>NUMBER</b>	Specifies an electrode number from 1 to 50. Electrode numbers may be specified in any order. If <b>NUMBER</b> is not specified, electrodes will be automatically numbered in sequential order. This parameter cannot re-number electrodes already defined in ATLAS or other programs.
<b>pos</b>	This is one of the position parameters described below.
<b>reg</b>	This is a set of the region parameters described on the next page.
<b>SUBSTRATE</b>	Places the specified electrode at the bottom of the device and names the electrode, <i>substrate</i> .
<b>THERMAL</b>	Specifies that the electrode is treated as a boundary condition for heatflow simulation using GIGA.

### Position Parameters

<b>BOTTOM</b> or <b>SUBSTRATE</b>	Specifies that the electrode is positioned along the bottom of the device.
<b>LEFT</b>	Specifies that the electrode starts at the left-hand edge of the device. The electrode will be positioned from left to right along the top of the device.
<b>RIGHT</b>	Specifies that the electrode starts at the right-hand edge of the device. The electrode will be positioned from right to left along the top of the device.
<b>TOP</b>	Specifies that the electrode is positioned along the top of the device.

## Region Parameters

Device coordinates may be used to add regions to both rectangular and irregular meshes. In either case, boundaries must be specified with the **A.MAX**, **A.MIN**, **R.MAX**, **R.MIN**, **X.MAX**, **X.MIN**, **Y.MAX**, **Y.MIN**, **Z.MAX**, and **Z.MIN** parameters.

<b>LENGTH</b>	Specifies the length of the electrode in the X direction. It is not necessary to specify <b>X.MIN</b> , <b>X.MAX</b> , and <b>LENGTH</b> . If two of these parameters are specified, the value of the third parameter will be calculated.
<b>A.MAX</b>	Specifies the maximum angle of a 3D cylindrical electrode.
<b>A.MIN</b>	Specifies the minimum angle of a 3D cylindrical electrode.
<b>R.MAX</b>	Specifies the maximum radius of a 3D cylindrical electrode.
<b>R.MIN</b>	Specifies the minimum radius of a 3D cylindrical electrode.
<b>X.MAX</b>	Specifies the maximum x-boundary of the electrode.
<b>X.MIN</b>	Specifies the minimum x-boundary of the electrode.
<b>Y.MAX</b>	Specifies the maximum y-boundary of the electrode.
<b>Y.MIN</b>	Specifies the minimum y-boundary of the electrode.
<b>Z.MIN</b>	Specifies the minimum z-boundary of the electrode.
<b>Z.MAX</b>	Specifies the maximum z-boundary of the electrode.

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**Note:** If an electrode has been shortened to fit the current mesh, a warning message will be generated by ATLAS. Electrode placement can only occur at previously defined mesh nodes.

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## Grid Indices

As an alternative to the region parameters, you can use grid indices to define a region only when the mesh is rectangular although these parameters are not recommended. To define a region with a rectangular mesh:

1. Use the **X.MESH** and **Y.MESH** statements to specify grid indices.
2. Use the **IX.HIGH**, **IX.LOW**, **IY.HIGH**, and **IY.LOW** parameters to specify x and y values.

<b>IX.HIGH</b>	Specifies the maximum x-value of the grid index. The alias for this parameter is <b>IX.MAX</b> .
<b>IX.LOW</b>	Specifies the minimum x-value of the grid index. The alias for this parameter is <b>IX.MIN</b> .
<b>IY.HIGH</b>	Specifies the maximum y-value of the grid index. The alias for this parameter is <b>IY.MAX</b> .

<b>IY.LOW</b>	Specifies the minimum y-value of the grid index. The alias for this parameter is <b>IX.MIN</b> . Nodes, which have x and y grid indices, between <b>IX.LOW</b> and <b>IX.HIGH</b> and between <b>IY.LOW</b> and <b>IY.HIGH</b> are designated electrode nodes. Normally, horizontal planar electrodes will be used. In this case, <b>IY.LOW</b> equals <b>IY.HIGH</b> .
<b>IZ.HIGH</b>	Specifies the maximum z-value of the grid index. The alias for this parameter is <b>IZ.MAX</b> .
<b>IZ.LOW</b>	Specifies the minimum z-value of the grid index. The alias for this parameter is <b>IX.MIN</b> .
<b>IX.MAX, IX.MIN, IY.MIN, IZ.MAX, IZ.MIN</b>	These are aliases for <b>IX.HIGH</b> , <b>IX.LOW</b> , <b>IY.HIGH</b> , <b>IY.LOW</b> , <b>IZ.HIGH</b> , and <b>IZ.LOW</b> .

### MOS Electrode Definition Example

This example defines electrodes for a typical MOS structure.

```
ELEC X.MIN=0.5 LENGTH=0.25 NAME=gate
ELEC LENGTH=0.25 Y.MIN=0 LEFT NAME=source
ELEC LENGTH=0.25 Y.MIN=0 RIGHT NAME=drain
ELEC SUBSTRATE
```

### 3D Electrode Definition Example

The following example illustrates electrode definition for a 3D structure.

```
ELECTRODE NAME=ANODE X.MIN=0.5 X.MAX=1.0 \
Z.MIN=0.5 Z.MAX=1.0
```

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**Note:** In ATLAS, it is preferred to refer to **ELECTRODES** by name rather than number. Some functions, however, may require the electrode number. The syntax, **MODELS PRINT**, can be used to echo electrode numbers to the run-time output.

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